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ABSTRACT

A series of eight videoconferences was designed to help educational professionals improve schools by applying knowledge gained from research. During the videoconference programs, which are transmitted by satellite to facilities with receiving capacity, viewers can interact by telephone with the program presenters. Each program covers a specific topic and each has a "content partner" (a learning center, institute, teachers' association or other specialized group) that supplies expertise in the program area. The format of the program involves the presentation of two stories depicting classrooms or communities that have successfully integrated research with practice, and a question-and-answer session with the studio audience and remote viewers. In this document, a review of research on science education is followed by an overview of the third program in the series, which covers the topic of science instruction and learning. In this program, the first story illustrates the ways in which an instructional approach derived from research has enabled students in a high school class to increase their knowledge about science. The second story demonstrates how a community of researchers, scientists, and teachers works to provide a rich learning experience for middle school students in San Antonio, Texas. A series of follow-up activities relevant to the topic of science education is described. Additional materials include biographical information on videoconference participants, a list of resources on science instruction, a glossary of terms, and a 10-item reference list. (BC)

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SCHOOLS THAT WORK

The Research Advantage

GUIDEBOOK

3

Children as Explorers

PS 020826

An Eight-Program Videoconference

presented by the
North Central Regional Educational Laboratory
and the PBS Elementary/Secondary Service
in partnership with the
Institute for Research on Teaching and Project 2061, American Association for the Advancement of Science (AAAS)

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NCREL

The North Central Regional Educational Laboratory (NCREL) is one of ten federally supported regional educational laboratories in the country and serves the states of Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. NCREL works with education professionals in the region to support school restructuring to promote learning for all students, especially those most at risk of academic failure in the most rural and urban settings.

NCREL was created in 1984 by seven chief state school officers and 19 deans of education from colleges and universities. It is governed by a 29-member board of directors composed of the seven chief state school officers and representatives from higher education, business, labor, agriculture, local and intermediate educational agencies, and communities.

The Lab's efforts to respond to regional needs are focused around five major program areas which direct our efforts to those in greatest need and allow us to concentrate our resources in areas likely to result in the greatest impact: curriculum, instruction, and assessment; early childhood and family education; professional development; rural education; and urban education.

As an educational laboratory, NCREL assists schools, families, and communities in identifying and addressing the needs of our children and students and in redesigning schools so that they have a greater capacity to create learning environments appropriate to, and supportive of, the full diversity of student needs and circumstances. We believe a growing body of expertise embodied in theory, research, and practice is pointing toward ways in which the nation can fundamentally rethink, or restructure, its schools.

PBS

The PBS Elementary/Secondary Service (ESS), through and on behalf of PBS member stations, serves the instructional needs of students and teachers nationwide. ESS distributes educational programming and related materials for K-12 classroom use; promotes the use of PBS's primetime programming as a curricular resource; provides professional development for educators; and serves as a national advocate for the use of video and related technologies for learning.

The PBS Adult Learning Service (ALS) offers college-credit television courses through local partnerships of public television stations and colleges. Since 1981, more than 1,500 colleges, in cooperation with 300 public television stations, have enrolled more than one million students in ALS-distributed courses. In August 1988, ALS launched the PBS Adult Learning Satellite Service (ALSS) as a direct satellite service for higher education, offering a wide variety of programming.

Each program in the videoconference has a content partner, or partners, with expertise in the area. We have selected the Institute for Research on Teaching at Michigan State University and Project 2061, American Association for the Advancement of Science as a content partners for Videoconference 3, *Children as Explorers.*

Institute for Research on Teaching

The Institute for Research on Teaching (IRT), founded at Michigan State University in 1976, conducts research aimed at improving classroom teaching. Its efforts focus on many areas, including studies of classroom management strategies, student socialization, the diagnosis and remediation of reading difficulties, and teacher education. IRT researchers also examine the teaching of specific school subjects such as reading, writing, general mathematics, and science in order to understand how factors outside the classroom affect teacher decision making.

Researchers from such diverse disciplines as educational psychology, anthropology, sociology, and philosophy cooperate in conducting IRT research. They join forces with public school teachers who work at the IRT as half-time collaborators in research, helping to design and plan studies, collect data, analyze and interpret results, and disseminate findings.

Members of the IRT staff helped NCREL to identify important areas of research in science education, as well as teachers and schools whose work reflects this research. In addition, many of the principles and ideas presented in this guidebook and videoconference represent research conducted by IRT.

Project 2061, American Association for the Advancement of Science (AAAS)

Project 2061 is a comprehensive, reform initiative in science literacy sponsored by the American Association for the Advancement of Science. Its goal is to improve the quality, increase the relevance, and broaden the availability of science, mathematics, and technology education. It is driven by the vision that all American citizens must have an understanding of science to live in a world transformed by technological developments.

Project 2061's vision requires radical reform of our present educational system. Phase I, "what everyone should know," is already complete. Its report, *Science For All Americans* (available from Oxford University Press, Tel. 1-800-451-7556), identifies the knowledge, skills, and habits of mind that every student should have upon finishing high school. Phase II, "redesigning the education system," is now under way. Teams of educators at school-based sites are translating these learning goals into alternative "curriculum models" that school districts will develop locally into complete curricula. Accompanying "blueprints for action" on teacher education, instructional materials, testing, research, policy, and other school issues will address further changes needed in the system. Phase III, "making it happen," will strive to implement these reforms nationwide over the next decades. As a long-term and collaborative effort, Project 2061 can ready the nation through science literacy for the challenges of the 21st century.

What is a Videoconference?

The North Central Regional Educational Laboratory (NCREL) and the PBS Elementary/Secondary Service have been producing videoconferences together since 1987. Via satellite, videoconferencing allows the exchange of information across town or across the country. A growing number of organizations use this delivery system for staff development, corporate meetings, training sessions, and entertainment events.

Videoconferencing works like this: An "uplink" station transmits the live program to a communications satellite which then beams it to "downlink" sites. Any facility with a satellite dish and the proper receiving capacity can be a downlink site. When combined with a telephone hookup, videoconferencing becomes "interactive" with one-way video (viewers see the presenters on monitors although presenters cannot see the viewers) and two-way audio (viewers can call in and speak to the presenters). Another way to include an interactive component is to have a viewer call-in period following the live satellite transmission.

In 1990, NCREL and PBS produced a nine-part staff development videoconference series, *Restructuring to Promote Learning in America's Schools*. Although not geared specifically toward staff development, *Schools That Work: The Research Advantage* has been designed to help viewers develop the kinds of successful schools that ensure a successful future for all of us.

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SECTION 1

Overview of the Videoconference Series

The President of the United States and the National Governors Association recently set forth six goals to be achieved by the year 2000 (see page 3). *Schools That Work: The Research Advantage* is designed to provide educational research for schools and communities as they reflect upon and seek to implement these national education goals. A recent Gallup poll shows that most Americans strongly support the national goals. Each goal was rated as a high priority by at least 84% of those polled. However, at least 47% felt that reaching these goals by the year 2000 is unlikely.

The North Central Regional Educational Laboratory and the PBS Elementary/Secondary Service are committed to restructuring schools to promote learning. We believe that every child can learn. We also believe that it is in our nation's utmost interest to develop world-class schools that achieve these goals, for the sake of our children.

Scattered throughout America are schools that work. These schools involve teachers, students, administrators, parents, community members, and businesses. They illustrate how the application of learning research can lead to improved education and to the achievement of the national goals. These examples give us hope that we all can make the difference. This videoconference is designed to help viewers develop schools that work, schools that aim to meet the national goals using the research advantage.

Topics and Schedule

1991 (4:00-5:00 pm ET)	**1992** (4:00-5:00 pm ET)
Reading—October 10	Early Childhood Education—February 13
Mathematics—October 24	Drug-Free Schools—March 12
Science—November 14	School-to-Work Transition—April 2
Assessment—November 21	Interagency Collaboration—May 7

Audience

Schools That Work: The Research Advantage is designed primarily for teachers, administrators, and curriculum specialists, as well as staff of state education and intermediate service agencies. However, its fast-paced, informative style will appeal to school board members, parents, policymakers, Chapter I staff, teacher educators and their students, test makers, staff developers, and researchers interested in school improvement.

Videoconference Programs

Videoconference 1

Reading ▪ October 10, 1991 ▪ Children as Strategic Readers

Content Partner: Center for the Study of Reading (CSR), University of Illinois, Urbana-Champaign

Videoconference 2

Mathematics ▪ October 24, 1991 ▪ Children as Problem Solvers

Content Partners: National Center for Research in Mathematical Sciences Education, University of Wisconsin, Madison, and the National Council of Teachers of Mathematics

Videoconference 3

Science ▪ November 14, 1991 ▪ Children as Explorers

Content Partners: Institute for Research on Teaching, Michigan State University, and Project 2061, American Association for the Advancement of Science (AAAS)

Videoconference 4

Assessment ▪ November 21, 1991 ▪ Alternatives for Measuring Performance

Content Partner: National Center for Research on Evaluation, Standards and Student Testing (CRESST), UCLA

Videoconference 5

Early Childhood Education ▪ February 13, 1992 ▪ Meeting Children's Needs

Content Partners: National Association for the Education of Young Children (NAEYC) and the National Association of Early Childhood Specialists in State Departments of Education

Videoconference 6

Drug-Free Schools ▪ March 12, 1992 ▪ Preparing Students for Drug-Free Lifestyles

Content Partner: Midwest Regional Center for Drug-Free Schools and Communities

Videoconference 7

School-to-Work Transition ▪ April 2, 1992 ▪ Preparing Students for Work in the 21st Century

Content Partners: Institute on Education and the Economy, Teachers College, Columbia University, and the U.S. Chamber of Commerce

Videoconference 8

Interagency Collaboration ▪ May 7, 1992 ▪ Integrating Community Services

Content Partners: Study Group on School-Linked Integrated Services sponsored by the U.S. Department of Education and the Department of Health and Human Services

Videoconference Objectives

- To provide examples of how research empowers teachers, students, and whole communities
- To promote meaningful and self-directed learning for all students
- To focus national attention on issues of equity and excellence as schools and communities implement the national goals
- To demonstrate alternative ways that educators, parents, policymakers, and community members can work together to redesign schools for America's children
- To provide high-quality programming with up-to-date research for professional development libraries for educators
- To encourage schools and communities to reflect on the national education goals, well informed by the best of research and practice

The National Education Goals

Goal 1: By the year 2000, all children in America will start school ready to learn.

Goal 2: By the year 2000, the high school graduation rate will increase to at least 90 percent.

Goal 3: By the year 2000, American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.

Goal 4: By the year 2000, U.S. students will be first in the world in science and mathematics achievement.

Goal 5: By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

Goal 6: By the year 2000, every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning.

Rationale for the Videoconference Program Topics

The topics for this series were selected in part because they represent major areas of educational research and in part because they are all relevant to the national education goals. Although each topic area in the series involves different departments and school staff, it is important to understand that schools ultimately are part of one system. What happens in one area of schooling influences what happens in another area. This videoconference series presents two sets of thematically related programs.

- The theme connecting the first four programs (Reading, Mathematics, Science, Assessment) is that research in these areas forms the vision of learning and teaching that drives curriculum, instruction, and assessment. Further, many common threads exist in each research base such as teaching for understanding and collaborative learning.
- The theme connecting the last four programs (Early Childhood Education, Drug Education, School-to-Work Transition, Interagency Collaboration) is that traditionally these topics have been considered somehow outside the core of schooling—both conceptually and politically. Our intent is to demonstrate that they are vital for the achievement of all children. Further, the collaborative learning and higher order thinking, together with their assessment, needed in the subject disciplines are also vital to early childhood education, preparing students for drug-free schools, and the work environment.

Accordingly, NCREL and PBS strongly recommend that schools and community members watch all eight programs to develop a common language and common objectives. Indeed, we hope that schools and community members will use this series as a vehicle for debate and reflection about school reform and implementing the national goals.

Format of Each Videoconference Program

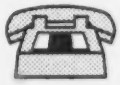
Live Satellite Transmission (1 hour)

For educational research to have a positive impact on schooling, it must be supported by effective classroom practices. With this in mind, the satellite transmission portion of each videoconference will focus on two "stories" depicting actual classrooms or communities that have successfully integrated research into practice. Each story will be followed by a question-and-answer session with the live studio audience. Remote viewers will be able to call in at any time during the program and give their questions to the telephone operator. The moderator will ask selected questions to the presenters throughout the program. Questions not answered on the air may be answered by phone or in print.

The first story will demonstrate effective classroom practices. The second will portray the rich teaching and learning environment created through community involvement in schooling. Each program in the videoconference series draws upon the best of research and practice to address critical questions that schools and communities need to resolve if they are to implement the national goals. Specifically, each program will illustrate the following:

1. How research has changed an individual teacher and the lives of his/her students
2. How schools have used research in the community by involving parents or community members in planning, instruction, or assessment or have enabled teachers and students to engage in learning outside the traditional boundaries of the school

Participant Call-In (30 minutes)



Immediately following the satellite transmission of each videoconference, participants will be given the opportunity to "call in" with comments and questions for videoconference presenters. This segment does not include live video transmission. However, callers will speak directly to the presenters. Because this segment provides one-to-one contact between presenters and participants, it is the key to the interactive nature of the conferences.

SECTION 2

What Does Research Say About Science?

The Need for Science Education Reform

Three major arguments have been used to point out the need for reform in science education. First, America's economic position appears to be declining. The affluence and international power of the United States are a result of our technical preeminence which is dependent on workers who are scientifically literate. Consequently, the blame for this economic decline is often placed on educational institutions for inadequately preparing students.

The second argument for reform arises out of the data that show that many students are simply not taking advanced science classes, and those who do are scoring below other technological nations. Further, reports that discuss low morale among teachers and low expectations for student achievement also address the crisis that science education is facing.

The final argument, although not voiced as often because it is not tied to economic decline or dropping test scores, is that improved science education can play a significant role in liberating human thought. Throughout history, advances in science have had significant influences on society that have allowed improvements in the living conditions and affluence of many people. For example, in ancient Egypt it was discovered, through scientific study, that there was a consistent pattern of relationship between astronomical events (the seasons) and of the flooding of the Nile. The cultivation of the fertile Nile river valley was then possible because people could predict the future; nomads became farmers. Because of scientific thinking, lives often are transformed forever. Opportunities for thinking about new things and thinking in different, more powerful ways becomes possible.

Poor ability in science, math, and technology will certainly hamper our ability to maintain a leading role in the global village. It is imperative, therefore, to carefully, thoughtfully, democratically, but urgently engage in the task of science education reform. Fortunately, research in three major areas including scientific thought, learning, and teaching is providing the groundwork for science education reform.

Knowledge About Scientific Thought

Goal 4 of the national education goals is to produce students who are first in the world in science achievement. For the attainment of that goal to be possible, a major aim of science education must be to help students to become good at "scientific thought." From a teaching and learning perspective, research is helping educators to better understand the nature of scientific knowledge by shifting their beliefs away from the notion of science as a collection of facts and processes to one in which science is a tool useful for everyday experience.

In the past, scientific knowledge was generally perceived as a collection of statements about the world. Recently, however, teachers are recognizing that scientific knowledge provides conceptual and technological tools that allow people to describe and explain how the world works with power and precision, and to achieve a richer understanding and appreciation of the world they experience. For example, when taken only as a fact, the statement that plants make their own food (from water, carbon dioxide, and light) may be an interesting piece of trivia good for a correct answer on a test, but not very useful. When considered as a tool, however, this concept can help children explain much about their experience with living organisms (e.g., why plants have leaves, why plants die without light, why plants do not have mouths, and so on).

Unfortunately, traditional science classrooms and textbooks usually present scientific facts, formulas, and definitions as a body of content to be mastered. Children come away from their science classes with the belief that the goal of scientific processes is to allow scientists to acquire this knowledge. The result is that children do not attain conceptual understanding. They remain unable to apply science to their own experience and therefore see little value in pursuing scientific study. If this trend continues the results will be devastating. A highly technological society depends on people who can engage in scientific thought through which they can solve the various problems that face mankind. We cannot afford to turn kids off science.

How can educators turn kids *on* to science? The answer lies in helping children engage in experiences that require them to use scientific knowledge and processes as tools as they make sense of their experiences. This solution demands that the science classroom be transformed into an inquiry-based culture — a community of explorers — where curiosity, creativity, and questioning are valued, where resources and opportunities are made readily available, and where students can "work" like scientists engaged in the process of collective sensemaking. Critical thought develops in this culture as new ideas are encouraged and where all of them — from the teacher, students, and textbook — are subjected to review and analysis by the scientific community of students. Children will come away from these experiences with the ability to use scientific knowledge to describe, explain, predict, and control their world.

Knowledge About Learning

Not only has research given us a new way to view scientific knowledge, but it also has provided significant findings on the nature of student learning. Research has shown that people construct new knowledge by modifying what they already know. Students develop informal "theories" and "hypotheses" about why certain phenomena occur based on their own observations and experiences—at home and in school. Sometimes their knowledge is on the right track, sometimes it is completely wrong. The process of building on what children know is metaphorically similar to succession (the gradual and orderly process of ecosystem development) in each student's "intellectual ecology." New ideas sometimes compete with old ideas, others are supported by them. New ideas can thrive and "take root" only if the students can work out the complex relationships between the new and the old and see the many connections between science and their personal knowledge. Successful teachers respond to this challenge by studying their students, learning how they think about the world in general and about the particular topics that they will study. With this knowledge, teachers can guide their students through the complex and difficult process of conceptual change.

Project 2061, the comprehensive science literacy initiative sponsored by the American Association for the Advancement of Science, has identified several important research-based principles of learning from cognitive science that have implications for science education.

- **Learning is not necessarily an outcome of teaching.** The results of cognitive research indicate that, even with what is considered to be good instruction, many students understand less than we think they do. This includes students who are academically successful as well as those who are not. Therefore, teaching must strive to help students develop understanding (not just recall) and must develop assessment strategies to measure this understanding. Teachers must base their curriculum around the "less is more" principle that involves identifying and emphasizing the most important concepts and skills, that concentrates on the quality of understanding rather than the quantity of information.
- **What students learn is influenced by their existing ideas.** Understanding occurs when students make connections between concepts (ideas). Concepts are learned best when they arise in a variety of contexts, are represented in a variety of ways, and when students have a chance to use the concepts on authentic tasks.
- **Learning generally occurs from concrete to abstract.** Science involves representing one's understanding of the physical (concrete) world in abstract symbol systems (e.g., formulas that describe moving objects in physics, and schematic drawings of the circulatory system in biology). Therefore, learning should proceed from common, describable experiences to the development of symbolic representation.

- **Learning to do well involves practice in doing.** Students cannot learn to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire other desirable skills unless they are permitted and encouraged to do those things over and over in many contexts.
- **Effective learning requires feedback.** Students must be able to feel free to express ideas and to receive analysis and comment from their peers. Once given, this feedback provides the grist for students to reflect on their ideas and performance, and to see relationships among items of knowledge and to test their validity.
- **Expectations affect performance.** The culture of the science classroom must provide support and encouragement for the belief that all students can "think like scientists." When students get the message that they cannot achieve, the likelihood is that they will fail.

Knowledge About Teaching

Teaching is a difficult and complex craft. Successful teaching is similar to building a house or a bridge. It is an inherently complex and demanding process for which simple rules are insufficient. Successful teachers must build classroom communities in which students work productively to achieve understanding. For most teachers, this will be possible only if they have:

- An extensive base of knowledge about science, about their students, and about teaching
- The ability to facilitate learning in a community of "student scientists"
- Adequate teaching materials and other tools
- Administrative support and encouragement
- Time to prepare, to respond to students, and to reflect on their teaching

Project 2061's Suggestions for Good Science Instruction

Suggestion	Explanation
Start with questions about nature.	Begin with questions about phenomena that are interesting and familiar to students. Encourage students to observe, collect, handle, describe, become puzzled by, ask questions about, and argue about the devices, organisms, materials, shapes and numbers in their environment.
Engage students actively.	Provide many and varied opportunities for collecting, sorting and cataloging; observing, note taking and sketching; interviewing; polling; surveying; using instruments such as microscopes, thermometers, and cameras; dissecting; measuring; counting; graphing; computing; planting; systematically observing; and so on.
Concentrate on the collection and use of evidence.	Provide students the freedom to judge the relevance and interpret the evidence of their scientific enterprise.
Provide historical perspectives.	Place scientific ideas within historical contexts so students understand that ideas change and evolve over time and that science influences and is influenced by historical events.
Insist on clear expression.	Provide opportunities for written and oral expression. Expression is necessary to communicate ideas, is the forum that real scientists use, and is a powerful vehicle for working out one's understanding.
Use a team approach.	Design projects which require collaborative participation. "Real" science is done in groups, and students learn the responsibilities of team work.
Do not separate knowing from finding out.	Help students develop appropriate methods for finding answers for various scientific problems. The nature of the problem should dictate the method of inquiry. The goal is for students to develop scientific knowledge as well as scientific habits of mind.
Deemphasize the memorization of technical vocabulary.	Provide opportunities for students to discover relationships between concepts and to use concepts to solve problems. Understanding, not memorization, is the goal of science instruction.

Science and the Community

Children have rich experiences in their everyday lives outside of school that can provide the basis for scientific inquiry, both formal and informal. Teachers can help students learn how to recognize opportunities for scientific thinking in movies, TV, radio, records, books and magazines, home computers, museums, zoos, parties, clubs, rock concerts, sports, and so on. Parents can encourage their children to think scientifically by asking them questions, seizing opportunities when their children are naturally curious, and participating in the explorations of their worlds. The community can provide a rich source of opportunities for children to learn science. Additionally, members of the community are a rich source for students in the ways that they use science (and scientific thinking) in their occupations.

Issues of Equity

In the past, girls have typically not achieved as well in science as boys although there is no evidence that boys are naturally better at science than girls. On the contrary, studies have shown that girls have excellent aptitudes in the skills required to do science. Therefore, schools must provide girls with better access to science courses. This includes squelching the tacit assumptions that girls should not be in science. It also means designing science instruction so that it can build on the experiences of girls as well as boys.

Minority populations are under-represented in both science classes and technical careers and don't do as well as non-minority populations. Part of this may be attributed to home and community influences that do not value science achievement. Equity issues are complex, but research suggests that when given equal access, all groups can succeed in science. Thus, it is necessary to remove obstacles and to provide mechanisms for all children to become scientifically literate.

Conditions Necessary for Improvement in Science Education

Science for All Americans (published by Project 2061) lists four considerations to achieve scientific literacy in America.

1. The curriculum must be changed so that it:
   - Covers a reduced amount of material
   - Weakens or eliminates subject-matter boundaries
   - Pays more attention to the connections among science, mathematics, and technology
   - Presents the scientific endeavor as a social enterprise that influences and is influenced by human thought and action
   - Fosters scientific ways of thinking
2. Effective science instruction must be based on learning principles that derive from research and on the best practice that is consistent with the spirit and character of scientific inquiry.
3. Educational reform must be systemic, dealing with all aspects and components of the educational system. It must focus on the learning needs of all children, in all subjects, and in all grade levels. Positive conditions must be established and maintained if reform is to be sustained.
4. Reform must be collaborative, involving administrators, university faculty members, community, business, labor, and political leaders, as well as teachers, parents, and students.

SECTION 3

Overview of Program 3: Children as Explorers

Program Objectives

- To provide the major findings from research and practice in science
- To provide examples of excellence at both classroom and school levels
- To raise the kinds of questions that might be discussed in school and community forums

Program Outline

- The program opens with scenes from classroom demonstrations that serve as a preview of key ideas.
- Moderator Judson Hixson, and Beau Fly Jones, Project Director for the Video Series, both from the North Central Regional Educational Laboratory, introduce the videoconference series and Program 3.
- The first story illustrates how research has enabled Barbara Neureither's high school science class to achieve high levels of scientific thought.
- Researchers Charles Anderson and Andrew Ahlgren discuss the major findings from research reflected in Neureither's classroom approach.
- Hixson moderates questions and comments from the audience.
- The second story about the Anson Jones Middle School in San Antonio demonstrates a community of researchers, scientists, and teachers working together to provide a rich learning experience for students.
- Leacy Piper, science teacher at Anson Jones; Verconica Garcia, Vice Principal and Etta Tricksey, Reading Specialist join the panel to discuss the major findings from research and the impact of team approach in Piper's classroom.
- Hixson moderates questions and comments from the audience.
- Jones asks selected studio audience members to describe how the stories and discussion in this videoconference may influence their thinking.

Overarching Message

1. Scientific knowledge provides us not only with facts about the world but also with tools that allow us to describe and explain how the world works with power and precision, and to achieve a richer understanding and appreciation of all that we see around us.
2. Students construct new knowledge by modifying what they already know. New ideas can thrive and take root only if the students can work out the complex relationships between the new and the old, and see the many connections between science and their personal knowledge.
3. Successful teaching is an inherently complex and demanding process for which simple rules are insufficient. Successful teachers build classroom communities in which students work productively to achieve understanding.
4. In addition to an extensive base of knowledge about science, about their students, and about teaching, successful teachers must have the ability to facilitate learning. They must move from the traditional role of a giver of information to the new role of facilitator. This new role requires administrative support and encouragement and adequate teaching materials and other tools. Teachers must also have time to prepare, to respond to students, and to reflect on their teaching.

About Story 1: A Professional Development School

Barbara Neureither is a high school teacher at Holt High School in Michigan. The high school is committed to improving education through research, and is one of eight public schools in Michigan that have partnered with the Education Extension Service based at the Michigan State University College of Education. The purposes of this partnership are to develop and demonstrate new approaches to teaching and learning, continuing education for teachers, preservice education, and the organization and management of schools. These schools, designated Professional Development Schools, are working with MSU to demonstrate exemplary practice, conduct research and development, and provide resources and training to school staff.

This relationship has provided Ms. Neureither the opportunity to work closely with several faculty members and graduate students from the Science Education Department at MSU as they research inservice education. This research is driven by the "less is more" principle of Project 2061 that concentrates on the most important concepts and skills to provide depth in understanding.

Barbara Neureither's Classroom

Ms. Neureither believes that students mimic what they see in their teacher. As a result, she feels it is important for the teacher to model effective learning and teaching strategies and to exhibit enthusiasm and interest in the content. In Ms. Neureither's classroom, students work in groups, drawing on their experience to design and perform laboratory activities to solve problems. She acts as a facilitator, using her knowledge of the subject area to assist students in their work. This role requires a respect for students and their views of the world, the ability to help them make connections among facts, and the time to interact with them. It also requires a knowledge of students' attitudes, learning styles, and the way they approach new material. Thus, while the main concepts are the same in each of her classes, each is taught differently because they are student directed. Ms. Neureither uses the knowledge gained from her research to concentrate on the most important concepts in science and to plan a curriculum in which students discover the need for new skills. For example, students are not taught how to use microscopes until that skill is needed to solve a problem.

Classroom Strategies and Sequence of Events

Ms. Neureither uses a variety of strategies in her classroom. She begins each lesson with an object of interest, a "hook," to generate curiosity about the subject. Next, she uses questioning and probing techniques to identify students' interests and their knowledge of the subject area. She then uses this information to provide students with the opportunity to build upon their prior knowledge. For example, she may present a problem or use one that has been identified by a student to begin the search for a solution. Students then work in groups to design a lab activity to find the solution and to provide her with a list of materials needed to perform the activity during the next class.

In conducting their experiment, each student within a group is responsible for completing his/her assigned tasks. The group decides upon this division of labor and reports it to her. All groups are responsible for reporting their findings orally to the other groups and each member must submit a paper on the activity. Ms. Neureither provides closure to the activity by leading the class in a discussion of what was learned from their collective work.

Assessment Strategies

In assessing performance, Ms. Neureither uses a variety of assessment strategies. Laboratory experiments are graded on their design and the degree of collaboration within the group and among groups. Experiments also are graded on the quality of reporting of the experiment and its results, both orally to other members of the class and in writing to the teacher. In addition, to assess student progress, Ms. Neureither uses open-ended questions, essays, descriptive writing, and problem-solving activities that require students to use their new knowledge in new situations.

The Senior Seminar

Each spring, Ms. Neureither teaches a "senior seminar" during which seniors at Holt High School take a course that teaches them how to teach basic science concepts to elementary school children. The idea for the senior seminar came from elementary teachers' complaints that they did not have enough prep time for science and from Barbara's observations that her students did not have a good grasp of basic science concepts.

These students work with the elementary teacher who decides the topic. The seniors interview the elementary students in the class to determine the extent of their prior knowledge in the topic area. Then, working with Ms. Neureither and the elementary teacher, the seniors develop a unit and coordinate it with the teacher's science instruction. Both demonstrations and laboratory activities are developed along with strategies for assessment. The seniors assist the teacher in teaching science two or three days a week.

The results of the senior seminar have been more "hands on" activities for the elementary school students, a richer level of science instruction in elementary classrooms, assistance for the teacher, and a deeper and more thorough understanding of basic science concepts for the seniors. As one senior student expressed it, "I thought I knew the basics and so did everyone else. But when I tried to teach them, I realized I didn't understand the concepts. Here I was, a senior in high school and I'd fooled myself, my friends, and my teachers!"

Holt High School

Holt High School is a suburban school located outside of Lansing, Michigan. Holt is a school of approximately 1,000 suburban and rural 10th, 11th, and 12th grade students. The philosophy of the science department is "less is more," which means that the most important concepts are identified and taught in greater depth. For example, Holt students have the opportunity to take 2-1/2 years of biology and study such topics as cell biology, zoology, botany, human physiology, genetics, and microbiology in depth. Science is taught using a constructivist approach that allow students to construct their own knowledge. The students are provided opportunities to make links between new knowledge and their existing knowledge through class discussions, group work, and laboratory experiments.

Holt's relationship with MSU has resulted in changes in almost all areas of the school. Teachers have the opportunity to continue to learn, to engage in research, to work together, to develop curriculum, and to experiment with new teaching strategies. It has affected the relationships among the administration, teachers, and students and created a community of learners.

Recommended Reading

American Association for the Advancement of Science. (1989). Project 2061: Science for all Americans. Washington DC: AAAS.

Driver, R. (1983). The pupil as scientist? Philadephia, PA: The Open University Press.

Driver, R., Guesne, E., & Tiberghien, A. (Eds.). (1985). Children's ideas in science. Philadelphia, PA: The Open University Press.

Additional Resources

A Private Universe. A video produced by Pyramid Film and Video. To order, write Pyramid Film and Video, 20801 Colorado Avenue, Santa Monica, CA 90404, or call 213/828-7577.

Basic Genetics: A Human Approach. This text, published by Kendall/Hunt Publishing Company, provides a series of articles and problems that are relevant to senior high school students and that can be integrated into most genetics programs.

The Science Teacher. A monthly magazine published by the National Science Teachers Association (NSTA).

About Story 2: Project 2061 in San Antonio

Leacy Piper, a science teacher at Anson Jones Middle School in San Antonio, Texas, has been dramatically influenced in her teaching by Project 2061. Project 2061 is a reform initiative in science literacy from the American Association for the Advancement of Science. The goals of Project 2061 are to improve the quality, increase the relevance, and broaden the availability of science, mathematics, and technology education for all Americans.

The San Antonio team, which consists of members from districts throughout the city and the surrounding area, is in the third year of Phase II of Project 2061. This phase involves teams of educators at school-based sites translating the Project 2061 goals into alternative "curriculum models" that school districts will then develop locally into complete curricula. Team members spent three summers working with scientists and expert consultants and researchers in education, science, technology, mathematics, and the social sciences .

A "Community" of Researchers, Scientists, and Teachers

Through Project 2061, Leacy Piper has joined both a local "community" of teachers and a national "community" of researchers, scientists, and educators. Working with them, she has dramatically changed her classroom strategies focusing on the nature of science.

Ms. Piper teaches five science classes of 20-25 students at Anson Jones Middle School. Although she is the only teacher at the school involved in Project 2061, she brings the 2061 approach to other teachers at the school as part of an interdisciplinary team of teachers who work together to integrate and coordinate their activities.

Classroom Strategies

Ms. Piper uses questioning extensively as a classroom strategy to determine the extent of her students' prior knowledge of a topic. She often begins with a brainstorming session in which students tell what they know about a topic. The focus is on the nature of science, and activities are designed to allow students to take what they know and develop an experiment to prove or disprove what they think. Students may design their own experiments, do research, collect data, and gather evidence to support their opinions. For example, in studying cells, some students designed activities to determine the color of a cell while others designed activities to identify parts of the cell. At the end of the unit, the same questions are asked and the students are required to use their results to support their positions.

Sequence of Classroom Events

Ms. Piper often begins her classes by setting up a short problem-solving activity to get her students thinking logically. The class talks about the activity for the day and then may either do research or design a laboratory activity to support their knowledge about a particular science topic. Ms. Piper acts as a coach as she provides materials, direction, and encouragement to assist them in proving or disproving what they thought about the topic. Her goal is to reinforce their knowledge or help them to recognize and change their misconceptions. At the end of the class, students share their discoveries with each other by explaining their research and laboratory activities.

Assessment Strategies

Both the students and the teacher are active participants in the assessment process in Ms. Piper's classroom. Each student writes a descriptive paper and identifies the percentage of time spent on a task. Students use a point system to grade themselves and each member of their group on their participation in the activity in areas such as research, writing, editing, and model building. Ms. Piper also rates each student in these areas. If there are large discrepancies between the individual's assessment of his/her performance and assessments of the other members of the group or the teacher, these discrepancy are addressed.

Anson Jones Middle School

Anson Jones Middle School serves 1,250 6th through 8th grade students who are from predominantly lower income, minority families. Of the students, 75% are Hispanic, 6% black, and 19% categorized as other. Of these, 75% participate in the free or reduced lunch program.

The goal of the school is to help students use their minds well. The belief is that every student can learn. Students are organized into interdisciplinary teams of approximately 100-130 members. Student teams are paired with a team of five or six teachers representing the academic disciplines of science, history, math, English, and reading. The teachers meet for 45 minutes each day to integrate and coordinate their activities. These collaborative meetings provide them an opportunity to share information about students who are having difficulty, to more quickly identify learning problems, and to make scheduling decisions. The "team" concept allows students and teachers to get to know each other, to bond, and to develop a true sense of community and ownership. The goal of the program is to personalize each student's education. The emphasis is on student mastery of higher-order thinking skills, activating a student's prior knowledge, and building on this knowledge.

One result of the team concept is that the roles of teachers and students have been transformed. They have moved from teacher as giver of information and students as recipients to teacher as coach and the students as workers. The teachers' roles have changed in other ways as well. They were responsible for developing a mission statement that sets goals and standards for the school, and have been given a high degree of autonomy to develop strategies to achieve those goals. Teachers develop their own curriculum and determine what resources they will use. As a team, they decide the amount of time to be spent on a subject in a class day, when and where the team will go on field trips, and even the assignment of students to classes. Each team also has the flexibility to decide how they spend their time and the extent to which they coordinate their subject areas.

Recommended Reading

Anderson, C. W. (1990). Strategic teaching in science. In B. F. Jones, A. S. Palincsar, D. S. Ogle, & E. G. Carr (Eds.). Strategic teaching and learning: Cognitive instruction in the content areas (p. 73-91). Alexandria, VA: Association for Supervision and Curriculum Development.

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Newmann, F. (1990, April). Linking restructuring to authentic student achievement. Bloomington, IN: Indiana University Annual Education Conference.

Osborne, R., & Freyberg, P. (Eds.). (1985). Learning in science: The implications of children's science. Auckland: Heinemann.

Smith, D., & Neale, D. (1989). The construction of subject matter knowledge in primary science teaching. In Advances in research on teaching: Subject matter knowledge (Vol. 1). Greenwich, CT: JAI Press.

Wiggins, G. (1989, May). A true test: toward more authentic and equitable assessment. Phi Delta Kappan, 708-713.

Teaching Approaches

Teaching Approach	Traditional Approach	Ms. Neureither's Approach	Ms. Piper's Approach
Collaboration	Students work together on lab activities with each having assigned tasks. Reports are written individually.	Students collaborate in groups of four in lab activities; groups use and rely upon knowledge of individuals within the group and in other groups.	Students work together to design experiments and complete lab activities. They share results with each other and with other groups.
Grouping	Students generally are placed in homogeneous groups or assigned by the teacher.	Students have a voice in forming groups. Groups are formed to allow for individual differences.	Students form heterogeneous groups, and have a voice in the formation of the groups. Groups are based on prior knowledge or interest.
Activities	Lecture on science concepts, individual worksheets and lab sheets. Science text used as primary source of information. Lab activities assigned to reinforce concepts explained in the text.	Students' interests and prior knowledge drive classroom activities. Science concepts are taught primarily through investigation and lab activities. Students design labs with teacher guidance. Many texts used as a resource.	Class "brainstorms" to identify "what they know" about a science concept. Students determine what they want to know and design experiments to prove/disprove their understanding. Students report findings to the whole class. Text is used as a resource.
Interaction	Teacher assigns questions which can be answered from information presented in the text. Interaction is teacher directed.	Teacher asks open-ended questions and uses questioning techniques to involve students in a discussion to determine areas of interest and extent of prior knowledge. Teacher acts as facilitator, circulating among groups providing assistance. Students interact with each other and teacher to share information.	Teacher acts as coach, asks questions designed to encourage logical thinking, and provides needed materials. Students interact with each other and with the teacher.
Assessment	Teacher grades students using objective and subjective tests and worksheets based on information presented in the text.	Teacher grades laboratory experiments on design, degree of collaboration, oral reporting of results and written reports. Open-ended questions, essays, descriptive writing, and problem-solving activities are also used.	Students and teacher participate in the assessment process through individual and group conferences. The teacher uses descriptive writing and a point system to assess individual and group progress. Individuals within each group also assess each other.

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Teaching Approach	Traditional Approach	Ms. Neureither's Approach	Ms. Piper's Approach
Self-Directed Learning	Students usually work independently except on lab activities. Labs are highly structured and assigned by the teacher. Lab reports are written individually.	Students are encouraged to develop their own experiments and collaborate with each other and other groups. Students are encouraged to find their own solutions to problems and follow their interests.	Students design their own experiments to prove what they know. Students learn to work together in groups and share information with other groups.
Skill Instruction	Students are taught the vocabulary of science and concepts in the abstract, then complete assigned lab activities or experiments to reinforce concepts presented in the text.	Students learn science concepts by designing and analyzing lab activities. Texts are used as a resource. Instruction is designed to help students relate new ideas to their knowledge based.	Students learn how to "brainstorm," to identify their own knowledge base, then design experiments to prove "what they know." They learn to use the data collected to prove or modify their understanding.
Understanding Students' Thinking	Teacher tries to understand students' personalities, interests, and general aptitude for science.	Teacher tries to understand how students think about the particular topics and activities in the curriculum and to use their ideas as a basis for instruction.	Teacher tries to understand how students think and uses this information to make instructional decisions.
Planning and Preparation	Teacher uses content to be covered and instructional activities as a basis for planning and preparation.	Teacher uses students' thinking and its relation to scientific thinking as a basis for planning and preparation.	Teacher uses students' prior knowledge and thinking strategies for planning and preparation.
Support System	Teacher plans and teaches largely alone, with text and laboratory as primary support systems.	Teacher is supported by collaborative planning and discussions with colleagues, graduate students, and university professors and administrative arrangements that make this possible.	Teacher receives support from Project 2061 team, other teachers in her school team, and the administration.

Viewers' Guide for Program 3: Children as Explorers

Things to look for during the program...	Spaces for taking notes
How do the teachers and researchers define scientific literacy? How do their definitions compare to those of my school?	
How do Barbara Neureither and Leacy Piper provide their students with motivation and opportunities to develop scientific thinking?	
How do teachers seek to understand their students thinking and how do they use this understanding to make instructional decisions?	
What instructional and assessment strategies do the two teachers have in common?	
How are the community members of San Antonio involved in curriculum redesign?	
How do the teachers in this program measure success in teaching strategies? In what ways do they involve students in this process?	
How do the approaches presented in this program address the national goals concerning science achievement?	

SECTION 4

Follow-Up Activities for Participants

Activities for Teachers

The examples of excellence in this program clearly show that in successful schools, teaching is a multidimensional activity. One of the most powerful of these dimensions is that of "teacher as researcher." Not only do teachers need to use research in their practice, they need to participate in "action" research in which they are always engaging in investigation and striving for improved learning. The key to action research is to pose a question or goal, and then design actions and evaluate progress in a systematic, cyclical fashion as the means are carried out. Below are four major ways that you can become involved as an action researcher.

1. Use the checklist found at the end of this section to evaluate your school and teaching approaches.

2. Implement the models of excellence presented in this program. Ask yourself:
   - What outcomes do the teachers in this program accomplish that I want my students to achieve?
   - How can I find out more about their classrooms and schools?
   - Which ideas can I most easily implement in my classroom and school?
   - What will I need from my school and community?
   - How can I evaluate progress?

3. Form a team and initiate a research project. A research project can be designed to generate working solutions to a problem. The issues for your research group to address are:
   - What is the problem or question we wish to solve?
   - What will be our approach?
   - How will we assess the effectiveness of our approach?
   - What is the time frame for working on this project?
   - What resources do we have available?
   - What outcomes do we expect to achieve?

4. Investigate community needs and integrate solutions within your class activities. Relevant questions include:
   - What needs does the community have in terms of science?
   - What can be done by my class to meet community needs (e.g., helping community members understand and act on the fact that they can make a difference in the ecology)?
   - What skills and resources does the community have that could benefit my students?
   - What kind of relationships can my class forge with the community?

5. Establish support groups consisting of school personnel and community members. The goals of these groups are to:
   - Share teaching and learning experiences both in and out of school
   - Discuss research and theory related to learning
   - Act as mentors and coaches for one another
   - Connect goals of the community with goals of the school

Activities for Schools, Parents, and Community Members

The following are activities that groups such as your PTA, church, and local Chamber of Commerce can do together with your schools.

1. Visit your school informally for discussions using the checklist on page 26.

2. Consider ways that schools and community members can work together to provide:
   - Materials for a rich learning environment (e.g., real literature in print and audio form, computers)
   - Opportunities for students and teachers to learn out of school
   - Opportunities for students to access adults as role models, tutors, aides, and experts
   - Opportunities for students to provide community services such as surveys, newsletters, plays, and tutoring
   - Opportunities for students to participate in community affairs
   - Opportunities for administrators, teachers, or students to visit managers and company executives

3. Promote school and community forums to debate the national education goals:
   - Invite your local television and radio stations to host school and community forums.
   - Have "revolving school/community breakfasts" (community members visit schools for breakfast once or twice a month, changing the staff and community members each time).
   - Gather information on the national education goals and their assessment.
   - Gather information on alternative models of schooling.
   - Gather information on best practices and research in the classroom.
   - Examine the vision of science teaching and learning set forth in the Project 2061 publication, *Science for all Americans*.
   - Invite science teachers in your area to discuss the changes being recommended by Project 2061.

Some of the important questions and issues to discuss in your forums are:

- Have we reviewed the national education goals documents to arrive at a common understanding of each goal?
- What does it mean to be excellent in science?
- What will students be like who learn in schools that achieve the goals?
- What must schools be like to achieve the goals?
- Do we agree with the goals, and how high do we rate each?
- What is the reason for national pessimism about their achievement?
- How are our schools doing now in terms of achieving each?
- Why is it important for us to achieve the goals?
- What are the consequences for our community if we don't achieve them?
- What assumptions are we making about the future in terms of Knowledge, Technology and Science, Humanities, Family, Change, Population, Minority Groups, Ecology, Jobs, Global Society, and Social Responsibility? Discuss in terms of each of the goal areas.

4. Consider ways to use *Children as Explorers* to promote understanding and commitment from school staff, parents, and community members.

Checklist for Excellence in Science Instruction

The items below are based on best practices of the teachers and researchers in Program 3. The checklist can be used to look at current practices in your school and to jointly set new goals with parents and community groups.

Vision of Learning

- ☐ Meaningful learning experiences for students and school staff
- ☐ High enjoyment of scientific investigation
- ☐ Restructuring to promote learning in the classroom
- ☐ High expectations for learning for all students as set forth by Project 2061
- ☐ A community of explorers in the classroom, in the school, and outside the school
- ☐ Teachers and administrators committed to achieving the national education goals as exemplified by Project 2061

Curriculum and Instruction

- ☐ Curriculum based on the "less is more" principle
- ☐ Curriculum that calls for a comprehensive repertoire of learning and problem-solving strategies
- ☐ Collaborative teaching and learning involving student-generated questioning and sustained dialogue among students and between students and teachers
- ☐ Teachers building new information on student strengths
- ☐ Authentic tasks in the classroom such as solving everyday problems, collecting and analyzing data, investigating patterns, and keeping journals
- ☐ Opportunities for students to engage in learning out of school with community members
- ☐ Homework that is challenging enough to be interesting but not so difficult to cause failure
- ☐ Respect for multiple cultures and perspectives
- ☐ A rich learning environment with places for children to investigate real world phenomena and think on their own
- ☐ Instruction that enables children to develop an understanding of scientific concepts as well as a mode of scientific thought

Assessment and Grouping

- ☐ Assessment that informs and is integral to instruction
- ☐ Assessment sessions that involve the teacher, student, and parents
- ☐ Performance-based assessment such as portfolios that include drafts, projects, and inquiry logs
- ☐ Multiple opportunities to be involved in heterogeneous groupings, especially for students at risk
- ☐ Public displays of student work and rewards

Staff Development

- ☐ Opportunities for teachers to attend conferences and meetings for science instruction
- ☐ Occasions for teachers to become researchers
- ☐ Opportunities for partnerships between teachers or schools and colleges or universities
- ☐ Opportunities for teachers to observe and coach other teachers
- ☐ Opportunities for teachers to try new practices in a risk-free environment

Involvement of the Community

- ☐ Community members' and parents' participation in science instruction as experts, aides, guides, or tutors
- ☐ Active involvement of community members on task forces for curriculum, staff development, assessment, and other areas vital to learning
- ☐ Opportunities for teachers and other school staff to visit informally with community members to discuss the life of the school, resources, and greater involvement of the community

Policies for Students at Risk

- ☐ Students at risk integrated into the social and academic life of the school
- ☐ Policies/practices to display respect for multiple cultures and role models
- ☐ A culture of fair assessment practices

SECTION 5

Biographical Information

Videoconference Participants

Andrew Ahlgren is the Associate Director of Project 2061: Education for a Changing Future, American Association for the Advancement of Science in Washington, D.C. He is on leave as professor in the Department of Curriculum & Instruction at the University of Minnesota. Dr. Ahlgren's published research includes books and articles on biological rhythms, innovations in school laboratory work, evaluation of curriculum, research methodology, diverse innovative techniques for measurement of student attitudes, and multivariate analysis of data. In addition, Dr. Ahlgren has consulted with a variety of academic and commercial organizations ranging from Massachusetts General Hospital and Northern States Power Company to Encyclopedia Britannica Films and the National Assessment of Educational Progress. He served as evaluation consultant for UNESCO in Thailand and was twice a Fulbright lecturer on science education at the Weizmann Institute of Science in Israel.

Charles W. (Andy) Anderson is an associate professor in the Department of Teacher Education at Michigan State University and a senior researcher with the Institute for Research on Teaching. His research identifying how students make sense of science and how teachers can improve or change the way that students think about the world has been published in a variety of research journals and book chapters. Dr. Anderson has served as the Lead Consultant for the state of Michigan on the New Science Objectives committee, a consultant to the American Association for the Advancement of Science (AAAS) during Phase II of Project 2061, and is an elected member of the board for the Association for Research and Science Teaching. Prior to joining Michigan State University, Dr. Anderson taught middle school science and math, and served as a Peace Corps volunteer on a science education project in Korea.

Veronica Garcia is the Vice-Principal of Anson Jones Middle School in San Antonio, Texas. As the grade level administrator, she acts as consultant for the 6th grade interdisciplinary teams. Together the interdisciplinary teams and Mrs. Garcia plan curricula, field trips, assemblies, and logistics. The interdisciplinary teams focus on building a community environment where the students and teachers get to know each other well. The goal of the community concept is to personalize each student's education. Prior to joining Anson Jones Middle School, Mrs. Garcia was an English Coordinator.

Beau Fly Jones is Director of Curriculum, Instruction, and Assessment at the North Central Regional Educational Laboratory. Dr. Jones holds a Ph.D. in Educational Psychology from Northwestern University. She has expertise in the areas of cognitive learning and effective comprehension instruction. Before becoming a member of the NCREL staff, Dr. Jones served as Special Projects Coordinator for the Chicago Public Schools, and was a developer of their instructional materials in several areas, particularly social studies and reading. Since her arrival at NCREL in 1985, she has published over 25 articles and books on dimensions of thinking, cognitive instruction, and applications of technology to curriculum development. In 1990, she was Project Director for NCREL's national videoconference series, *Restructuring to Promote Learning in America's Schools.*

Judson Hixson is Director of Professional Preparation and Development at the North Central Regional Educational Laboratory and Associate Director of Technology and Information at the Midwest Regional Center for Drug-Free Schools and Communities. Mr. Hixson is a Ph.D. candidate at the University of Chicago and holds both a Bachelor and Master of Arts degree in Educational Psychology from the University of Chicago. Before joining NCREL, Mr. Hixson was Administrative Coordinator in the Chicago Public Schools. He also served as Educational Director for the Chicago Urban League, and as on-loan consultant to the National Urban League for educational policy development and congressional relations. He has teaching experience at all grade levels, as well as experience in university administration. He has served as consultant to a wide variety of organizations, such as the U.S. Department of Justice Community Relations Division.

Barbara Neureither is a high school science teacher at Holt High School in Holt, Michigan. In her life science, biology, cell biology, human genetics, and science seminar courses, she provides opportunities for students to construct their own knowledge through class discussions, group work, and lab work. Ms. Neureither is the sponsor of Holt High School's Science Olympiad team which placed first in the state of Michigan and fifth in the nation out of 10,000 schools. In addition to her high school teaching responsibilities, Ms. Neureither is a member of the College of Education at Michigan State University where she conducts workshops to help teachers with science curriculum development. As a member of the College of Natural Science, she is a science consultant who helps with curriculum development efforts for school districts throughout Michigan.

Leacy Piper is a 7th grade life science teacher at Anson Jones Middle School in San Antonio, Texas. She came to education with a science background from working as a medical technologist and a research chemist for Shell Oil. As one of the school-based Project 2061 educators, she is currently adapting the Project 2061 learning goals to the needs of San Antonio students. She has worked with the Texas Education Agency to develop a statewide science curriculum model to inservice 160,000 elementary teachers. Ms. Piper is currently working with Stanford University developing and field testing curriculum for a Middle School Human Biology Program. Within her own district she has developed a summer science, math, and language arts program to enrich at-risk students. She has also organized an elementary/middle school partnership program for Anson Jones and its feeder elementary schools.

Etta Tricksey is a 7th grade reading teacher at Anson Jones Middle School in San Antonio, Texas. She believes that children should enjoy reading, and allows the students to select their own materials for class. Mrs. Tricksey uses a variety of activites to promote thinking in her reading class. An example is an activity which encourages the students to extend a story by adding original information which relates to what they have read. Mrs. Tricksey has 29 years of teaching experience, 16 at Anson Jones.

SECTION 6

Glossary

Assessment Techniques used to determine how well students are achieving, what students know and can do, and to what extent an instructional strategy or program is working.

Coaching Providing support in studying new skills, polishing old ones, and encouraging change.

Collaborative Groups A temporary grouping structure used primarily for developing attitude outcomes. Students of varying abilities work together to solve a problem or to complete a project.

Cooperative Learning Students working together in small heterogeneous groups to achieve a common goal.

Curriculum An operational plan for instruction that details what students are to know, how they are to achieve the curricular goals, what teachers are to do to help students, and the context in which learning and teaching occur.

Exhibitions of Mastery Students demonstrate their grasp of skills and knowledge. They select a variety of methods including oral presentations, doing a skit or video presentation, diorama with poster explanations, or a portfolio with samples of their work. They are encouraged to incorporate presentation skills and become comfortable speaking in public. These types of assessment are in place of the traditional testing which follows the unit.

Inquiry A process of investigating a phenomena, devising and working through a plan, and proposing a solution to the problem. A disposition of inquiry is necessary for successful problem solving.

Manipulatives Physical objects used to represent, or model, a problem situation. For example, base-ten blocks can be used to represent problems involving the multiplication of numbers.

Modeling Showing a student how to do a task with the expectation that the student will then emulate the model. Modeling often involves talking about how one thinks through a task.

Representation A model, or alternate form, of a problem situation or aspect of a problem situation used in finding a solution. For example, problems can be represented by objects, pictures, words, or mathematical symbols.

Understanding The relationships between segments of knowledge that the learner forms through thinking, reasoning, and problem solving.

SECTION 7

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